

Quantitative analysis of privatization

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Abstract

In recent years, the economic policy of privatization, which is defined as the transfer of property or responsibility from public sector to private sector, is one of the global phenomenon that increases use of markets to allocate resources. One important motivation for privatization is to help develop factor and product markets, as well as security markets. Progress in privatization is correlated with improvements in perceived political and investment risk. Many emerging countries have gradually reduced their political risks during the course of sustained privatization. In fact, most risk resolution seems to take place as privatization proceeds to its later stage. Alternative benefits of privatization are improved risk sharing and increased liquidity and activity of the market. One of the main methods to develop privatization is entering a new stock to the markets for arising competition. However, attention to the capability of the markets to accept a new stock is substantial. Without considering the above statement, it is possible to reduce the market's efficiency. In other words, introduction of a new stock to the market usually decreases the stage of development and activity and increases the risk. Based on complexity theory, we quantify how the following factors: stage of development, activity, risk and investment horizons play roles in the privatization.

I. INTRODUCTION

In recent years, economics and finance have been at the focus of many researchers in various fields. Among these researchers, physicists, Mathematicians and engineers attempt to apply existing knowledge from mathematics' approaches to economic problems [1, 2, 3, 4, 5, 6, 7, 8, 9]. The aim is to characterize the statistical properties of given markets time series with the hope to provide useful information to create new models able to reproduce experimental facts.

In economics, a financial market is a mechanism that allows people to participate as investors and easily buy and sell financial securities, commodities, etc at low transaction costs and at prices. In fact, producers have obtained a feed back from consumers. This is because consumers are their investors and their benefits lies in the development and success of the markets. In finance, financial markets facilitate the raising of capital (in the capital markets), the transfer of risk (in the derivatives markets) and international trade (in the currency markets). Among various economic problems, privatization has been an interesting one for many researchers [10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21]. Nowadays, the economic policy of privatization, which is defined as the transfer of property or responsibility from government to business, is a matter of interest in many countries. We assume that the goal of government is to promote efficiency. Indeed, it is now quite difficult to find a country that has not embarked on a program to involve the private sector in their management, ownership, and financing. Even if privatization processes seem to pursue a common global trend, the extent of divestiture varies greatly across countries. In some countries, governments have followed a consistent and continuous privatization policy as a part of wider reform packages, while in some others, it has been sporadic and small-scaled [12]. However, there is no doubt that privatization has had a major impact on capital markets and trading volumes. Privatization can range from a simple contract with a private vendor to the sale of a public asset. There are many reasons why governments turn to privatization. Cost reduction is one motivation for privatization. The desire to transfer risk from the public sector to the private sector can lead to privatization. A higher level of service and an absence of expertise within the governmental unit can also be another reasons. The time frame with which a project needs to be completed could also factor in the decision for privatization. A final potential reason for privatization is the flexibility provided

by the private sector. One of the methods for privatization is share issue privatization. In this method, the government sells shares of the government run company which can then be traded on various stock markets, though a developed secondary market is necessary [22]. Indeed, financial market development is mentioned as one of the primary objectives of privatization. A remarkable wealth of evidence shows the correlation between financial market development and privatization. Yet, stock markets develop also in the absence of privatization [11]. Proponents of privatization believe that private market actors can more efficiently deliver any good or service that government can provide. Privatization proponents' faith in the market is philosophically based on an economic principle of competition: where there is a profit to be made, competition will inevitably arise, and that competition will inevitably draw prices down while increasing efficiency and quality. However, some would point out that privatizing certain functions of government might hamper coordination, and charge firms with specialized and limited capabilities to perform functions which they are not suited for.

It has been clear in the transition economies that the success of the privatization program depends on the strength of the markets within the same country, and vice versa. Thus, the impact of privatization will differ across countries depending on the strength of the existing private sector. Similarly, the evidence suggests that the effectiveness of privatization depends on institutional factors, such as the protection of investors. However, privatization can also stimulate the development of institutions that improve the operations of markets. A key decision to be made by the privatizing government is the method through which the state-owned asset is transferred to private ownership. This decision is difficult because, in addition to the economic factors such as valuing the assets, privatization is generally part of an ongoing, highly politicized process. Some of the factors that influence the privatization method include: (1) the history of the assets ownership, (2) the need to pay off important interest groups in the privatization, (3) the capital market conditions and existing institutional framework for corporate governance in the country, (4) the sophistication of potential investors, and, (5) the governments willingness to let foreigners own divested assets [23]. The complexity of the goals of the process means that different countries have used many different methods for privatizing various types of assets. Although financial economists have learned much about selling assets in well-developed capital markets, we still have a limited understanding of the determinants and the implications of the privatization method

for state-owned assets. Theoreticians have modeled some aspects of the privatization process but, to be tractable, their models must ignore important factors. Empirical evidence on the determinants of privatization is also limited by the complexity of the goals of the privatization process.

Progress in privatization is correlated with improvements in perceived political risk. These gains tend to be gradual over the privatization period and are significantly larger in privatizing countries than in non-privatizing countries, suggesting that the resolution of such risk is endogenous to the privatization process. Changes in political risk in general tend to have a strong effect on local stock market development and excess returns in emerging economies, suggesting that political risk is a priced factor. The resolution of political risk resulting from successful privatization has been an important source for the rapid growth of stock markets in emerging economies. The recent wave of privatization sales in developing countries should have altered the perceived political risks of these countries considerably, especially if governments have successfully implemented the announced privatization plans. Such shifts in political risk tend to affect the attractiveness of equity investments and are therefore related to stock market development. Many emerging countries have gradually reduced their political risks during the course of sustained privatization. In fact, most risk resolution seems to take place as privatization proceeds to its later stage. The known benefits of privatization are reduction in public debt, improved incentives and efficiency, and better access to capital [24].

We relate how privatization depends on stock market development. Furthermore, liquidity, rather than capitalization, provides incentives for information acquisition to financial analysts. Based on recent researches, concepts of high activity and degree of development and low risk of the markets have been defined [25, 26, 27, 28, 29]. Some reports indicate that [28, 29] Level Crossing (LC) and Hurst exponent show remarkable differences between developed and emerging markets. Level Crossing analysis is very sensitive to correlation when the time series is shuffled and to probability density functions (PDF) with fat tails when the time series is surrogated.

II. LEVEL CROSSING ANALYSIS

Let us consider a time series $\{p(t)\}$, of price index with length n , and the price returns $r(t)$ which is defined by $r(t) = \ln p(t+1) - \ln p(t)$.

Let for a typical time interval T , ν_α^+ denotes the number of positive difference crossings $r(t) - \bar{r} = \alpha$ in time t (see figure 1) and let the mean value for all the time intervals be $N_\alpha^+(T)$ where [30]:

$$N_\alpha^+(T) = E[n_\alpha^+(T)]. \quad (1)$$

In other words, ν_α^+ is the average frequency of positive slope crossings of the level α .

For the homogeneous process, if we take a second interval of T immediately following the first we shall obtain the same result, and for the two intervals together we shall therefore obtain [30]

$$N_\alpha^+(2T) = 2N_\alpha^+(T), \quad (2)$$

from which it follows that, for a homogeneous process, the average number of crossings is proportional to the time interval T . Hence

$$N_\alpha^+(T) \propto T, \quad (3)$$

or

$$N_\alpha^+(T) = \nu_\alpha^+ T. \quad (4)$$

which ν_α^+ is the average frequency of positive slope crossings of the level $r(t) - \bar{r} = \alpha$. We now consider how the frequency parameter ν_α^+ can be deduced from the underlying probability distributions for $r(t) - \bar{r}$. Consider a time scale Δt of a typical sample function, if $r(t) - \bar{r} < \alpha$ at time t and $r(t) - \bar{r} > \alpha$ at $t + \Delta t$ or alternatively the changes in $r(t)$ is positive in the time interval Δt , there will be a positive crossing of $r(t) - \bar{r} = \alpha$,

$$r(t) - \bar{r} < \alpha \quad \text{and} \quad \frac{\Delta(r(t) - \bar{r})}{\Delta t} > \frac{\alpha - (r(t) - \bar{r})}{\Delta t}. \quad (5)$$

Actually what we really mean is that there will be high probability of a crossing in interval Δt if these conditions are satisfied [30].

In order to determine whether the above conditions are satisfied at any arbitrary location t , we must find how the values of $y = r - \bar{r}$ and $y' = \frac{\Delta y}{\Delta t}$ are distributed by considering

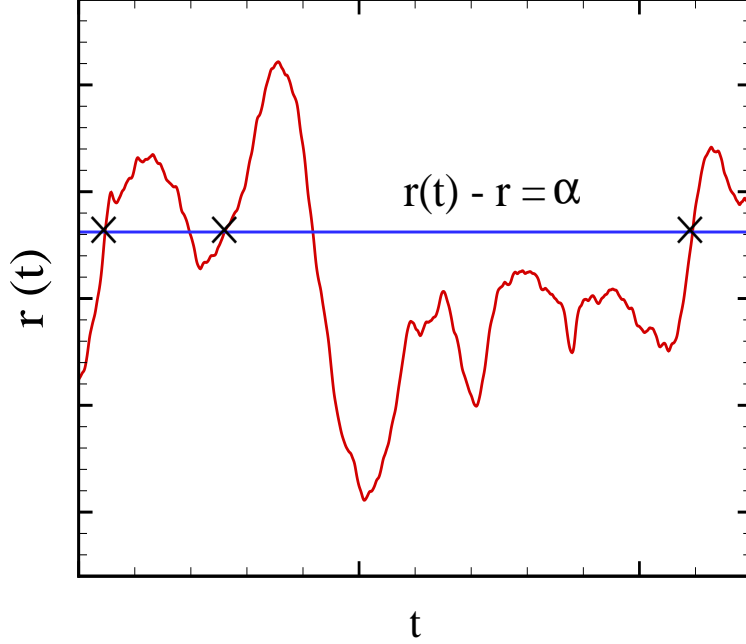


FIG. 1: Schematic positive slope crossings in a fixed level, α .

their joint probability density $p(y, y')$. Suppose that the level $y = \alpha$ and interval Δt are specified. Then we are only interested in values of $y < \alpha$ and values of $y' = (\frac{\Delta y}{\Delta t}) > \frac{\alpha - y}{\Delta t}$, which means that the region between the lines $y = \alpha$ and $y' = \frac{\alpha - y}{\Delta t}$ in the plane (y, y') . Hence the probability of positive slope crossing of $y = \alpha$ in Δt is [30]:

$$\int_0^\infty \Delta y' \int_{\alpha - y' \Delta t}^\alpha \Delta y p(y, y'). \quad (6)$$

When $\Delta t \rightarrow 0$, it is legitimate to put

$$p(y, y') = p(y = \alpha, y'). \quad (7)$$

Since at large values of y and y' the probability density function approaches zero fast enough, therefore eq.(6) may be written as [30]:

$$\int_0^\infty dy' \int_{\alpha - y' dt}^\alpha dy p(y = \alpha, y') \quad (8)$$

in which the integrand is no longer a function of y so that the first integral is just: $\int_{\alpha - y' dt}^\alpha dy p(y = \alpha, y') = p(y = \alpha, y') y' dt$, so the probability of slope crossing of $y = \alpha$ in dt is equal to [30]:

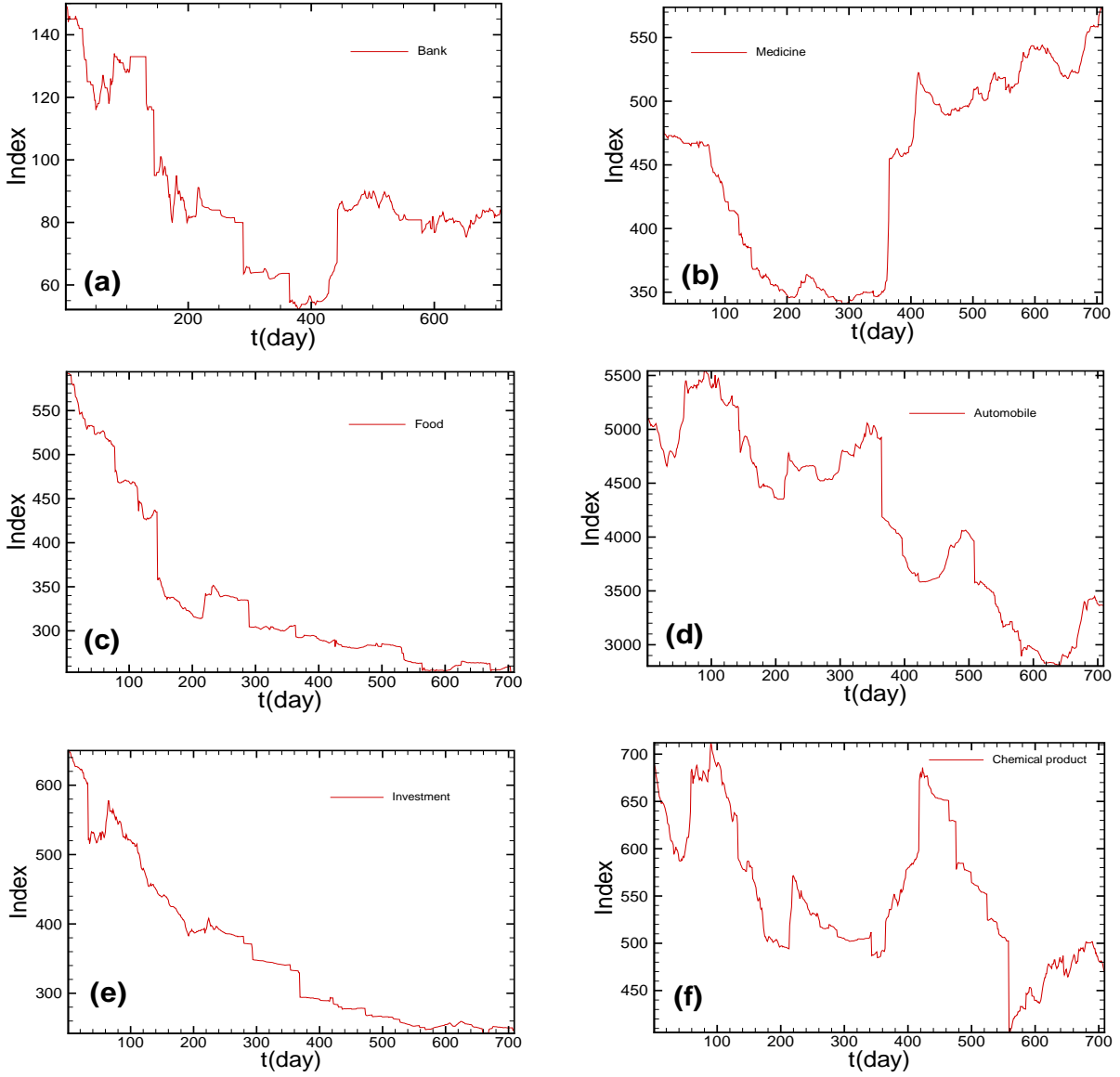


FIG. 2: Indices history (Jan. 2005 - Mar. 2008) of some TEPIX subgroups (a) Bank, (b) Medicine, (c) Food, (d) Automobile, (e) Investment and (f) Chemical products.

$$dt \int_0^{\infty} p(\alpha, y') y' dy' \quad (9)$$

in which the term $p(\alpha, y')$ is the joint probability density $p(y, y')$ evaluated at $y = \alpha$.

We have said that the average number of positive slope crossings in scale T is $\nu_{\alpha}^{+}T$, according to (4). The average number of crossings in interval dt is therefore $\nu_{\alpha}^{+}dt$. So, average number of positive crossings of $y = \alpha$ in interval dt is equal to the probability of

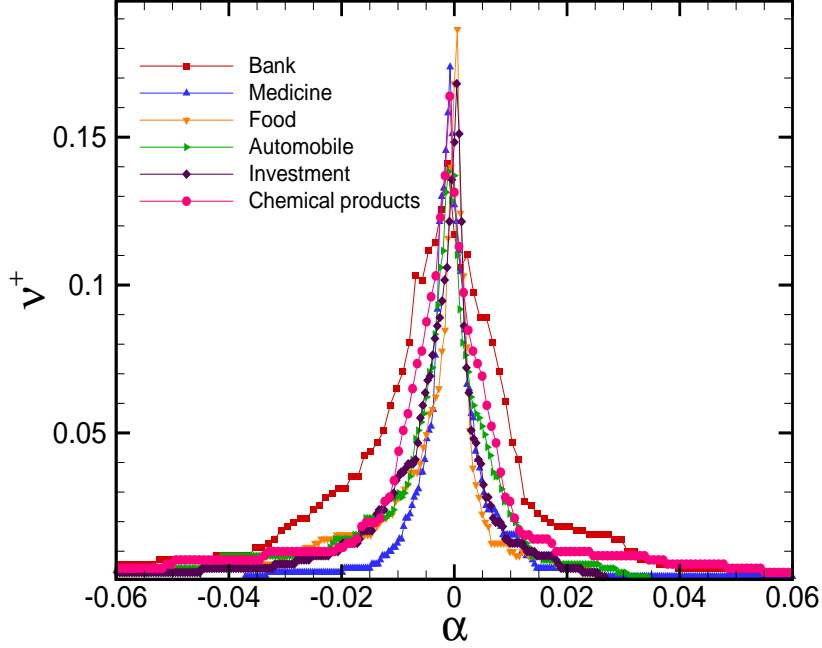


FIG. 3: Comparison of the positive Level Crossings of some TEPIX subgroup indices.

positive crossing of $y = a$ in dt , which is only true because dt is small and the process $y(t)$ is smooth so that there cannot be more than one crossing of $y = \alpha$ in time interval dt , therefore we have $\nu_\alpha^+ dt = dt \int_0^\infty p(\alpha, y') y' dy'$, from which we get the following result for the frequency parameter ν_α^+ in terms of the joint probability density function $p(y, y')$

$$\nu_\alpha^+ = \int_0^\infty p(\alpha, y') y' dy'. \quad (10)$$

Some authors have used other forms for ν_α^+ which are as follows [31]:

$$\nu_\alpha^+ = P(y_i > \alpha, y_{i-1} < \alpha) \quad (11)$$

$$\begin{aligned} \nu_\alpha^+ &= \int_{-\infty}^\alpha \int_\alpha^\infty P(y_i, y_{i-1}) dy_i dy_{i-1} \\ &= \int_{-\infty}^\alpha \int_\alpha^\infty P(y_i | y_{i-1}) P(y_{i-1}) dy_i dy_{i-1}, \end{aligned} \quad (12)$$

Let us also use the quantity $N_{tot}^+(q)$ as [28]

$$N_{tot}^+(q) = \int_{-\infty}^{+\infty} \nu_\alpha^+ |\alpha - \bar{\alpha}|^q d\alpha. \quad (13)$$

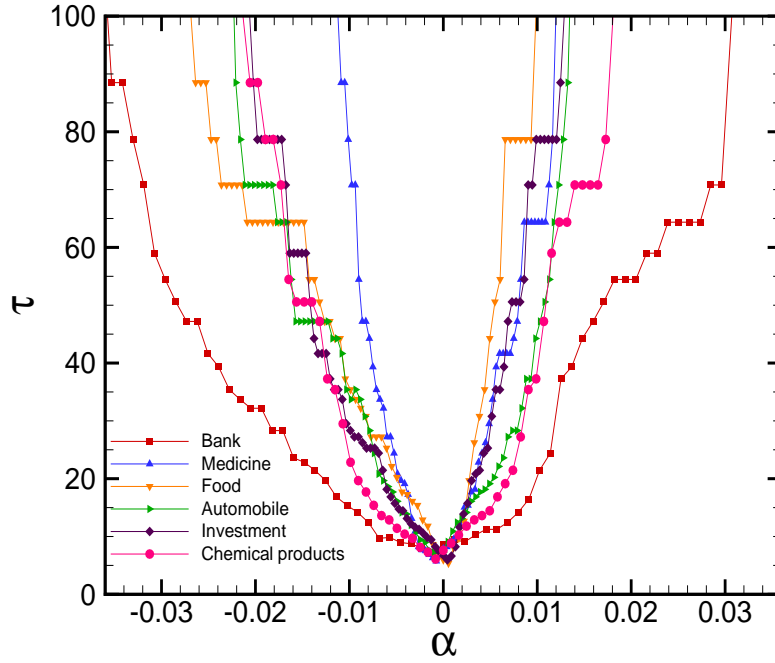


FIG. 4: Comparison of the waiting time of some TEPIX subgroup indices.

where zero moment (with respect to ν_α^+) $q = 0$, shows the total number of crossings for price returns with positive slope. The moments $q < 1$ give information about the frequent events while moments $q \gg 1$ are sensitive for the tail of events.

LC analysis is very sensitive to correlation when the time series is shuffled and to probability density functions (PDF) with fat tails when the time series is surrogated. To study the effects of correlations and probability density functions (PDF), we have evaluated N_{sh}^+ (which is the total number of positive-slope crossings of the height fluctuation series when it is shuffled) and N_{su}^+ (which is the total number of positive-slope crossings of the series when it is surrogated). The shuffling and surrogating procedures are explained in the following:

A. Shuffling procedure

A celebrated theorem of Aldous, Bayer, and Diaconis asserts that it takes $\frac{3}{2} \log_2 n$ riffle shuffles to randomize a deck of n cards, asymptotically for large n , and that the randomization occurs abruptly according to a cutoff phenomenon. Shuffling by random transpositions is one of the simplest random walks on the symmetric group: given n cards in a row, at each

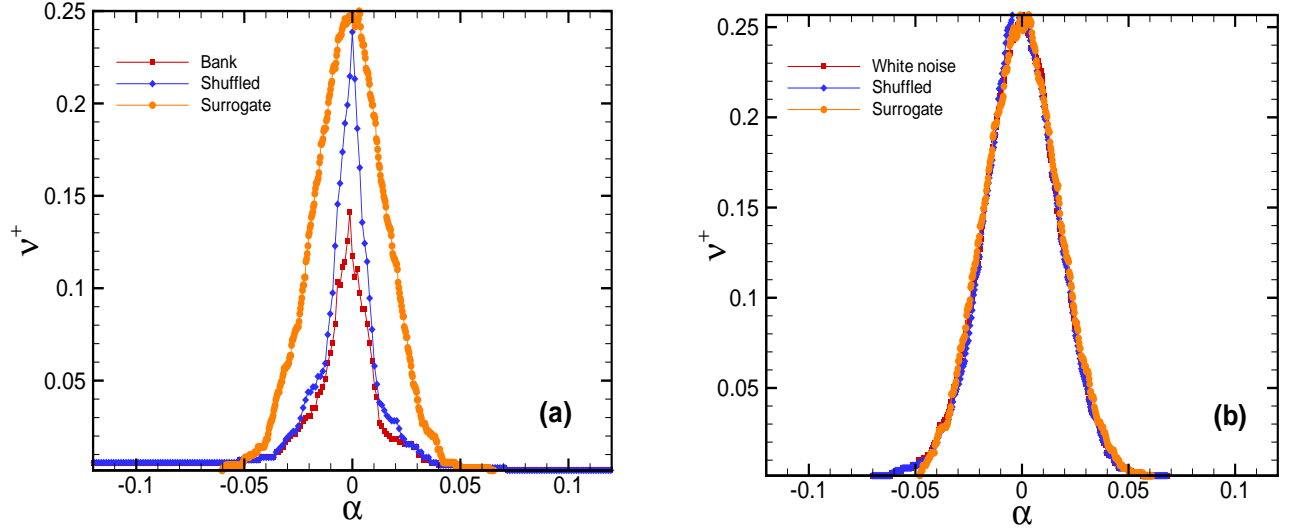


FIG. 5: Typical comparison of the positive Level Crossings of bank index, its shuffled & surrogate with a white noise (the standard deviations of the curves are the same).

step two cards are picked uniformly at random and exchanged. This shuffle was precisely analyzed in 1981 [32]. We have used random transpositions for shuffling our data. The long range correlations are destroyed by the shuffling procedure. As it will be pointed, in liquid markets, correlations of returns are small and in inefficient markets correlations are large. Hence, by comparing the original returns with the shuffled ones we can obtain the magnitude of correlations in the market and this can help us gain useful information about the market.

B. Surrogating procedure

Another procedure that is used for obtaining valuable information about the time series is surrogating procedure. In the surrogate method surrogates are generated by replacing the true phases with a set of pseudo independent distributed uniform $(-\pi, +\pi)$ generated by any good pseudorandom uniform subroutines [33]. The phase of the discrete Fourier transform coefficients of time series are replaced with a set of pseudo-independent distributed uniform $(-\pi, +\pi)$ quantities generated by any good pseudorandom uniform subroutines. The correlations in the surrogate series do not change, but the probability function changes

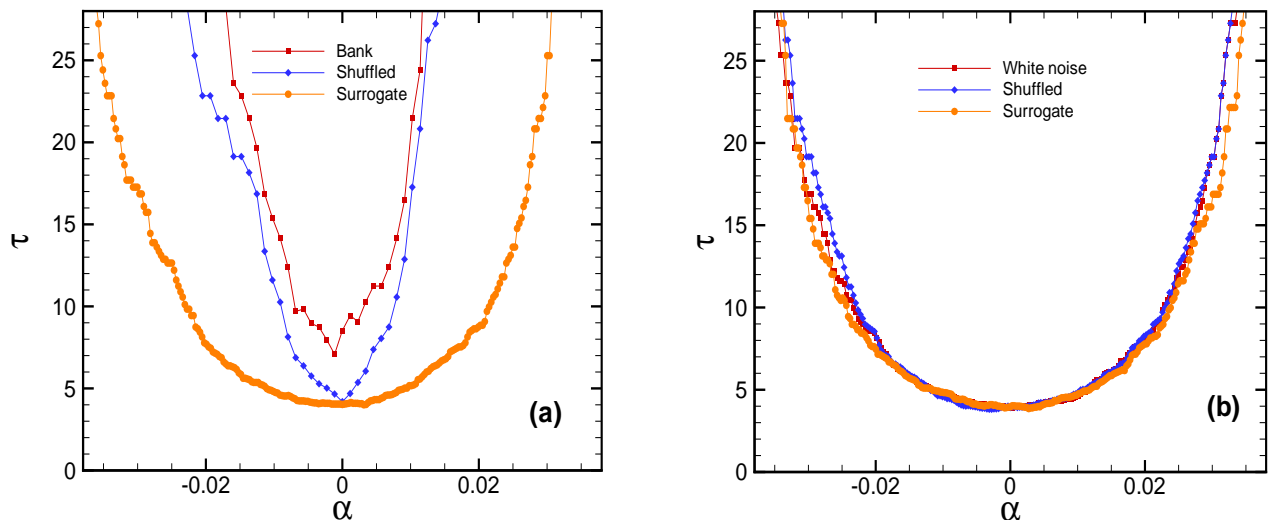


FIG. 6: Typical comparison of the waiting times of bank index, its shuffled & surrogate with a white noise (the standard deviations of the curves are the same).

to Gaussian distribution [29, 33, 34, 35, 36, 37, 38]. The main objective is to provide a kind of baseline or control against which the original data can be compared. The physical idea behind the surrogates method is that a nonlinear operation on a stationary random forcing process generates cross frequency coupling between complex amplitudes. The discrete Fourier transform (DFT) of the observed time series data is computed and then the phases of each complex amplitude of the DFT are replaced with independently distributed artificial uniform $(-\pi, +\pi)$ variates. The altered DFT is then inverse Fourier transformed to generate a surrogate time series. The randomization ensures that any phase coupling, and thus signs of nonlinearity, is destroyed in the surrogates.

III. THE STRATEGY TO DEVELOP THE MARKET

In general, a successful privatization program requires institutional changes that contribute significantly to the strengthening of the legal framework underlying equity investment. However, private control and policy reforms must be maintained during any political backlash. As a consequence, actual progress of privatization builds up confidence over time and this will lead to market deepening, investment and trading. This may explain why pri-

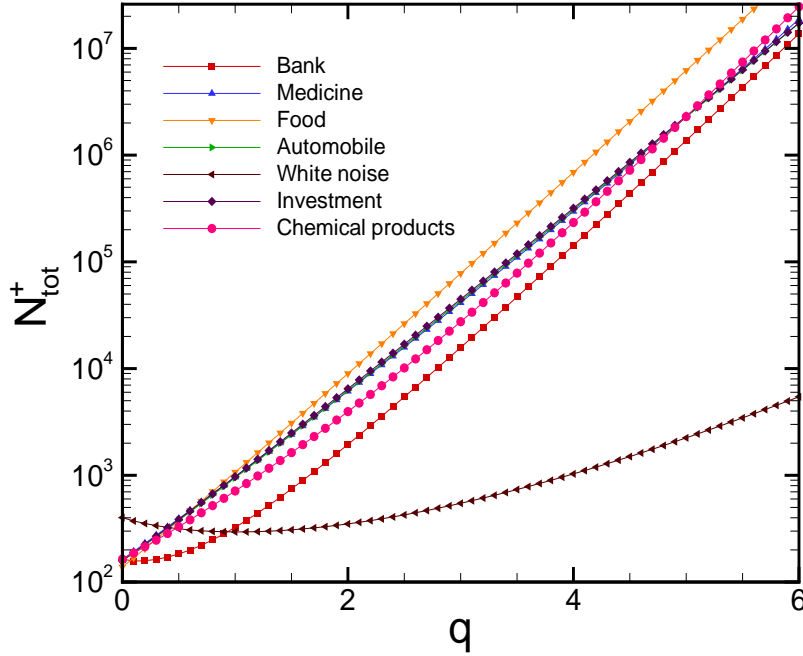


FIG. 7: Generalized total number of crossings with positive slope $N_{tot}^+(q)$ for some TEPIX subgroup indices.

vation may be contemporaneous or even precede successful stock market development. Alternative benefits of successful privatization are improved risk sharing and increased liquidity and activity of the market [24, 28, 29]. One of the main methods to develop privatization, is entering a new stock to the markets for arising competition. But attention to the capability of the markets to accept a new stock is substantial. Without considering the above statement, it is possible to reduce the market's efficiency. In other words, introduction of a new stock to the market usually decreases the stage of development and activity and increases the risk. It has been shown that inefficient markets' stage of development and activity are lower and their risk is higher than efficient markets [28, 29, 39].

The reason why, in very efficient markets of equities and currency exchanges correlations of returns are extremely small, is because any significant correlation would lead to an arbitrage opportunity that is rapidly exploited and thus washed out. Indeed, the fact that there are almost no correlations between price variations in efficient markets can be understood from simple calculation [3, 40]. In other words, liquidity and efficiency of markets control the degree of correlation, that is compatible with a near absence of arbitrage opportunity.

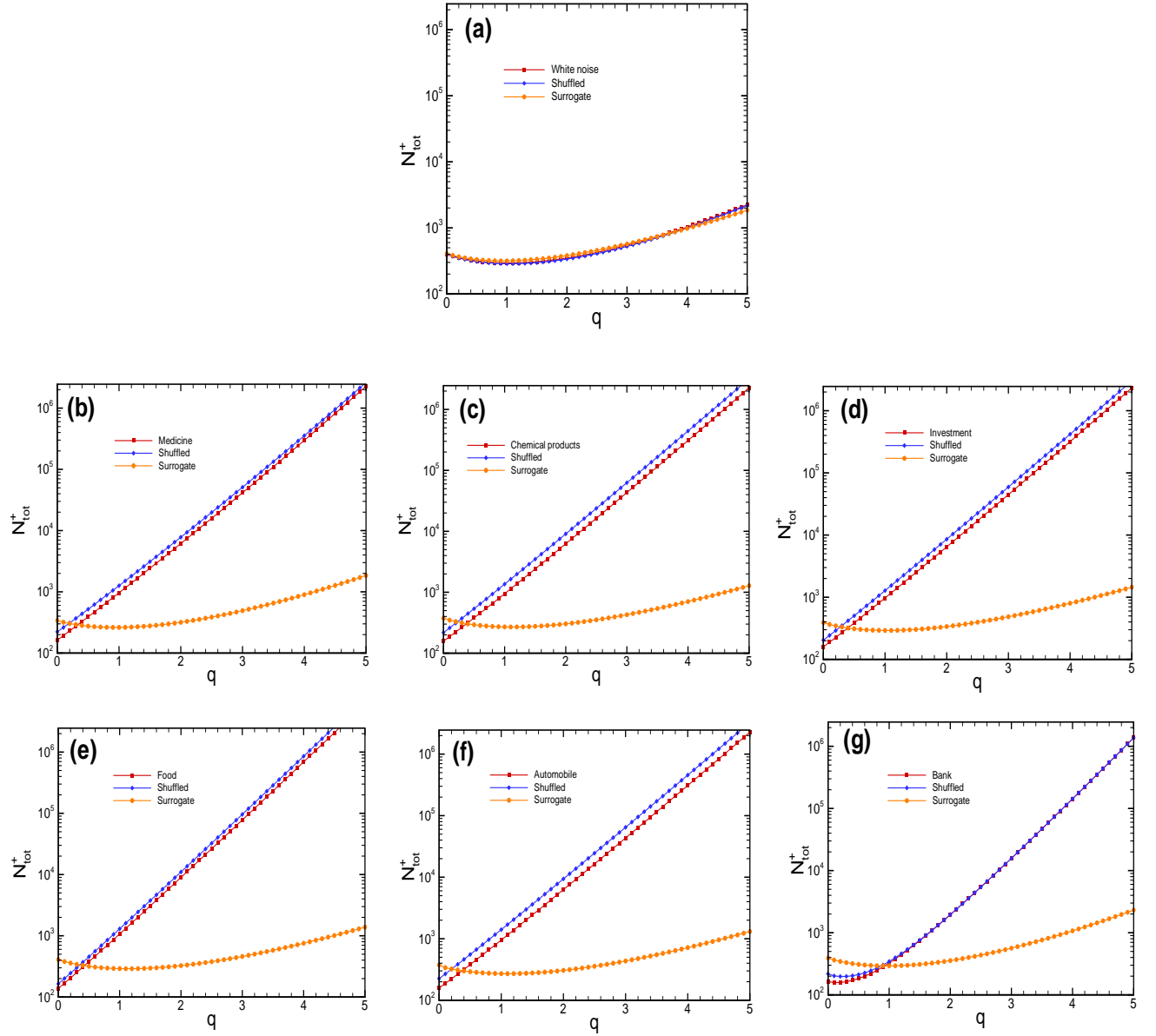


FIG. 8: Comparison of generalized total number of Level Crossings with positive slope $N_{tot}^+(q)$ of (a) White noise, (b) Medicine, (c) Chemical products, (d) Investment, (e) Food, (f) Automobile and (g) Bank with their shuffled and surrogate.

It is important to consider that, the more intelligent and hard working the investors, the more random is the sequence of price changes generated by such a market.

In the following subsections we try to explain more about activity, stage of development, risk and waiting times which can characterize the market and should be considered before privatization.

A. Activity

One of the parameters that should be considered before privatization is activity. When there is no sell and buy in the market, the prices are fixed without any fluctuation. One should pay attention that fluctuation is calculated with respect to the trading volume. With increasing the trading volume, the fluctuation decreases. Indeed, fluctuation is the sign of existence of sell and buy that is called activity [29]. High fluctuation could also increase the risk. The process of buy and sell or activity is a positive parameter which could be effective in determining the real price of the stock and in correctly distributing the wealth. It is obvious that by increasing activity, liquidity increases which can stimulate investors to enter their short-term investment to the market that can again increase (improve) activity. The liquidity of a product can be measured as how often it is bought and sold. Liquidity is characterized by a high level of trading activity.

B. Stage of development

Based on recent research for characterizing the stage of development of markets [25, 26, 27, 29], it is shown that the Hurst exponent (H) has sensitivity to the degree of development of the market. In liquid markets, correlations of returns are small because existence of any information in the market would lead the investors to get use of it and thus washed out. In contrast, if there is no correlation between price variations or if markets are perfectly efficient, the return on gathering information is nil. Therefore, there would be little reason to trade and markets would eventually collapse [41].

One of the important points in market development, is acceptability of the market development by investors. In emerging markets, there exist correlations and information (high value of Hurst exponent) which can stimulate the investors to gain benefits. If the development is accepted by investors, it will be a successful program. In this case, the market parameters improve (higher activity and stage of development and lower risk). In most developing countries and even in some developed countries, "they privatize just for privatization" and not for promoting efficiency, improving the operations of markets, reduction in public debt, etc and in this case there will occur an unsuccessful privatization. This happens because they have not enough attention to the above point and so these markets have

not the capability of accepting the new stocks and the development of privatization. This suggests that by considering the current situation, the rate of development and privatization should be controlled. Here, we could ask a question: why the investors do not get use of the present information besides the development?

A: Lack of "liquid investment": This means that the worth of the introduced stocks is more than the worth of the liquid investment. In this case liquidity of the stocks decreases. In other words, exchange of the stocks is reduced and so the liquidity of the market falls and there will be an inefficient and frozen market. In this case privatization is not a successful program for development of the market. In other words, before privatization, attention to the worth of the introduced stocks in comparison with the liquid investment is necessary.

B: Lack of financial security and high risk: This factor ruins the motives of investors for investment. This is one of the main problems in developing countries.

C: "Frozen investment": In some countries, there is not enough study or proper management program for privatization and instead of using privatization for the use of potential intelligence and investment, they privatize for privatization. For example, consider the case that government distribute some stocks between people who did not want to be investors on their own. Hence they do not participate in the exchange of stocks and currency and they form the "frozen investment". Thus they cannot increase the intelligence. These are the stocks that were frozen under the name of the government and now only the name is changed. While the aim of privatization is not the apparent change of the names of the investors.

Thus, for a successful privatization program these three parameters should also be considered. We intend to study development of the market from this aspect by using Level Crossing analysis.

LC with the power of correlation detection, is a useful tool to find the stage of development of markets [28, 29]. It is known that inefficient markets have long-range correlation. This sensitivity of LC to the market conditions provides a new and simple way of empirically characterizing the development of financial markets. This means that, in mature markets the total positive slope crossings, N_{tot}^+ is fixed or decreases under shuffling effectively, while in emerging markets, it is increased. Recently, many works have focused on the stage of development of the market [25, 26, 27, 28, 29, 42]. As far as stock markets are concerned, the Hurst exponents show remarkable differences between developed and emerging markets.

Di Matteo et al (2003) and (2005) found that the emerging markets have $H > 0.5$ whereas the developed ones have $H \leq 0.5$ [25, 26, 27].

C. Risk

Nowadays, the importance of risk is clear for everyone. As many researches have shown, many financial crisis such as Asian crisis during 1997-1998 have been related to the lack of suitable risk management. Indeed, risk is one of the important subjects that has been considered by most of the financial organizations e.g. banks, assurance companies etc. In other words, precise recognition of the financial markets and the means to maintain the stability in these markets, is one of the crucial ways to preserve the economic growth of the country. Risk management is one of the main tools for stability of financial markets. In fact, market risk is resulted from the high fluctuation (low frequency regime) in the prices of assets. Assets could be in the form of cash, stocks, lands, gold etc. All of these could have fluctuation in their prices and this is the main result to produce risk. Thus, assessing and pricing the risk properly is of substantial importance. Financial and credit risks [43, 44, 45, 46] play the main roles in bankruptcy of the financial markets. These continuous crisis due to the financial risk have better shown the necessity of attention to the management of risk.

In fact, most of the common methods for risk measurement is based on Value at Risk (VaR) [43, 44, 45]. VaR is a downside risk measure, meaning that it typically focuses on losses. Most of the common methods (ARCH models, variance-covariance, riskmetrics ...) are based on variance and the kinds of it. We want to look at risk from another point of view because of its importance. In fact, small fluctuation in the return of the prices have contribution in the variance and so in risk. But we mention that small fluctuation demonstrate the activity of the market which is a positive parameter. In a market with no buy and sell there is no fluctuation in the price. In this case the variance is zero and there is no risk. It means that we should consider more contribution from larger fluctuation. But we should pay attention to the point that risk is not a totally negative concept. Although the investors could hold their money in the banks without risk, they prefer to invest it in the markets that could have risk. This operation depends on the risk that an investor will take and this is due to two main factors: 1) The worth of his investment and 2) Human

psychology. Indeed, in average, the more his investment, the more risk he will take. One of the market factors is knowledge of distribution of the investors and their investment. It is clear that human psychology is important and this is related to social sciences.

D. Investment horizons

To speak about other aspects of the development of markets, we can mention investment horizons. By investment horizons we mean the expectation time for a specified benefit. The quantitative method that is used is inverse statistics which was introduced by Johansen et al [47, 48, 49]. This method has been formed by the main idea that the current prices are the results of the future expectation. In other words, in response to the question of "how to price in the available information?" for the case of a stock, one must consider how the available information affects future earnings of the company. This introduces some ambiguity as not only do peoples expectations to a largely unpredictable future differ, but so do their strategies. But how we can quantify the peoples expectations? One of the important parameters that affect peoples expectations is the expectation time which is defined as the specified time interval that one should wait for a specific change in the price value. The answer to this question can adjust the investors expectations with respect to for example investment horizons. This expectation time can help the investors to invest their money by considering the risk they can take and the fact that how long they intend to hold their investment before taking any profit. The risk that people are willing to take is a subject of the human psychology and social sciences. This can suggest that economics and financial problems are coupled with human sciences.

IV. APPLICATION

To study the market development, we have analyzed some selected TEPIX subgroup indices using Level Crossing analysis (Fig. 2). These indices are Bank, Medicine, Food, Automobile, Investment, Chemical products. The data are taken from Tehran Securities Exchange Technology Management Company (TSETMC) [50]. Log return time series, $r(t)$ of them from the same time interval: 3 January 2005 to 1 March 2008 have been analyzed. Data have been recorded at each trading day. In addition, we have compared the results

with a white noise as a standard reference.

According to Eq. 10 Level Crossing, ν_{α}^{+} , is calculated for the indices. Figure 3 shows a comparison of ν_{α}^{+} for TEPIX subgroups as a function of level α . It is clear that ν_{α}^{+} scales inversely with time, so $\tau(\alpha) = \frac{1}{\nu_{\alpha}^{+}}$ is a waiting time which the level α will be observed again. Figure 4 shows a comparison of $\tau(\alpha)$ for TEPIX subgroups. These figures show that the behavior of various indices is different.

Table I shows the waiting time for meeting various levels from high frequency to low frequency (tails) regimes: ($\tau(\alpha = 0)$) which is the mean of the levels, ($\tau(\alpha = \pm 0.005)$), ($\tau(\alpha = \pm 0.01)$) and ($\tau(\alpha = \pm 0.02)$) for all selected indices of TEPIX subgroups. The time interval $\tau(\alpha = 0)$ of Bank index is the largest (8.53) and the time interval $\tau(\alpha = 0)$ of Food index is the smallest (5.95) days which are in the same order. This means that in average, it takes more time for meeting the mean of the levels with positive slope for Bank index than Food index. In other words, the Food index lives more in the level $\alpha = 0$. As it is seen in the table I, there exists an asymmetric behavior when we are moving towards the tails (high levels) and this behavior is in such a way that there is a tendency towards the mean, except the index of Medicine. In all indices except Medicine index, the waiting time interval of right is larger than left tails. This means that when we are in the levels larger than mean we should wait more time for meeting this level with positive slope, than for the same opposite level. According to table I, in average, the waiting time interval in the tails for Bank index is the smallest, which means that it is financially motivated to absorb capital in this index.

The area under the curves of ν_{α}^{+} shows the total positive Level Crossings, N_{tot}^{+} which represents the activity of the market. As it is seen in table II, Food index has the smallest activity (138.17) and Bank index has the largest one (164.28). This should be noted that the values of the N_{tot}^{+} are reported for this time scale (3 Jan. 2005 to 1 Mar. 2008). As it is reported in table I, the waiting time of the Bank index is the smallest in various levels which means it is more active. Activity or the process of buy and sell is a positive parameter which could be effective in determining the real price of the stock and in correctly distributing the wealth. By increasing activity, liquidity increases.

Figures 5 and 6 show typical comparison of the positive Level Crossings and waiting times of an index (Bank index) and white noise with their shuffled and surrogate, respectively. In order to better compare the results, standard deviation of the white noise is chosen to be the same as the Bank index. It should be noted that, in these figures the standard deviation

of the shuffled and surrogate are kept the same as the original ones. Considering that, for a white noise, the Level Crossing curves do not change after shuffling and surrogating processes, any deviation from this behavior shows existence of statistical information and departure from the white noise. As it is seen in figure 5(a), when we are shuffling and surrogating the returns of Bank index, the Level Crossing curve changes. Hence, the area under the curves of the original and its shuffled and surrogate differs. As it is reported in table II, N_{tot}^+ , N_{sh}^+ and N_{su}^+ of the Bank index are 164.28, 218.31 and 389.83, respectively. As it is seen in figure 6, the waiting time for the Bank index and its shuffled and surrogate are shown. The waiting time for the surrogate of the Bank index grows much slower than the original and the shuffled series. This represents that the Bank index is far from the Gaussian function. This shows the existence of risk that will be studied later in this section. As it is seen in the figures 5 and 6, the difference between the surrogate of Bank index and white noise is much smaller than the difference between the shuffled Bank index and the white noise which lead us to the conclusion that the contribution from the PDF is larger than the contribution from the correlation. This is because the index is fat-tailed. This behavior is in good agreement with the results of the table II. As it is reported in this table, comparison between the relative differences for the Bank index ($|N_{sh}^+ - N_{tot}^+|/N_{tot}^+$ and $|N_{su}^+ - N_{tot}^+|/N_{tot}^+$ which are 0.33 and 1.37 respectively) will reveal that the contribution from the PDF is larger. The results of other indices are listed for better comparison.

Since activity, $N_{tot}^+(q = 0)$ is very sensitive to correlation, it changes when the time series is shuffled so that the correlation disappears. When the relative difference of the shuffled and the original series, $|N_{sh}^+ - N_{tot}^+|/N_{tot}^+$ is positive, the series is correlated and when this relative difference is negative, the series is anti-correlated. This behavior may not be seen when calculated directly by standard models. One of the advantages of Level Crossing method is that no scaling feature is explicitly required. Thus, by comparing the difference between $N_{tot}^+(q = 0)$ and $N_{sh}^+(q = 0)$ (after shuffling), the stage of development of markets can be determined. Smaller relative difference denotes larger stage of development. The results of this relative difference is listed in table II, which the minimum is 0.19 for Food index and the maximum is 0.38 for the Automobile index. These results show that the Medicine index is the index with highest stage of development and the stage of development of Automobile index is the lowest.

Also, activity, $N_{tot}^+(q = 0)$, is sensitive to deviation of PDF from normal distribution.

Thus, it changes when the time series is surrogated so that the PDF changes to a Gaussian one. When the relative difference of the surrogate and the original series, $|N_{su}^+ - N_{tot}^+|/N_{tot}^+$ is positive, the series is fat-tailed and when this relative difference is negative, Gaussian distribution is wider than the series. Thus, by comparing the difference between $N_{tot}^+(q = 0)$ and $N_{su}^+(q = 0)$ (after surrogating), the contribution of sudden changes in activity can be determined. Larger relative difference denotes larger risk. The results of this relative difference is listed in table II, which the minimum is 339.56 for Medicine index and the maximum is 408.60 for the Food index. All the relative changes are positive which means that all the indices are fat-tailed. Fat tails of a distribution refers to a much larger probability for large price changes than what is to be expected from the random walk or Gaussian hypothesis and they imply additional risk.

For a better comparison, Hurst exponent which was obtained by using the detrended fluctuation analysis (DFA) method [51, 52], are reported in table II too. As it is seen they are in agreement with the results of the Level Crossing method. But it should be noted that errors in evaluating the exponent is more. Inefficient markets are associated with high value of Hurst exponent and developed markets are associated with low value of the exponent. In particular, it is found that all emerging markets have Hurst exponents larger than 0.5 (strongly correlated) whereas all the developed markets have Hurst exponents near to or less than 0.5 (white noise or anti-correlated). As reported [25, 26, 28], at one end of the spectrum, there are stocks like Nasdaq 100 (US), *S&P500* (US), Nikkei 225 (Japan) and so on. Whereas, at the other end, there are TEPIX, the Indonesian JSXC, the Peruvian LSEG, etc. We notice that TEPIX belong to the emerging markets category and it is far from an efficient and developed market.

When we apply Eq. 13 for small q regime, high frequency events ($\alpha = 0$) are more significant, whereas in the large q regime, low frequency (the tails) is more significant. Figure 7 compares the generalized total number of positive slopes Level Crossings, $N_{tot}^+(q)$ of different indices and a white noise. In this figure, for better comparison, we choose the same variance for all of them. As it is seen in the figure, $N_{tot}^+(q)$ for the Bank index is below the other indices for $q \gg 1$ and the Food index is above them. This means that in these indices, Food index is higher in risk and Bank is lower. This figure shows how $N_{tot}^+(q)$ for the indices are deviated from a white noise. To know the reason of this deviation we compare the behavior of $N_{tot}^+(q)$ for each index with its shuffled and surrogate in figure 8. White noise

behavior has been plotted for a better decision. It is clear that $N_{tot}^+(q)$ of white noise and its shuffled and surrogate have the same behavior because a white noise is an uncorrelated series with normal distribution. The surrogated $N_{tot}^+(q)$ for all the indices shows little difference from the white noise. This means that PDF leads this deviation in our indices. $N_{tot}^+(q)$ for the moments $q \gg 1$ is sensitive to the tail of events which is the sudden changes. As it is shown in the figure for $q \gg 1$, the largest difference between $N_{tot}^+(q)$ for the original and the surrogate series is for Food index and the smallest difference is for the Bank index. This means that Food index is more risky than other indices and the risk of the Bank index is the smallest. Another point that should be noted, is that while for $q < 1$, $N_{tot}^+(q)$ is different for Bank index and its shuffled, this difference could not be seen for $q \gg 1$. This shows that the existence of correlation in high frequency regime is more than the low frequency regime.

Considering all of the above discussions and results, we notice that TEPIX and most of its subgroups belong to the emerging markets category and they are far from efficient and developed markets. Tables I and II compare the properties of these subgroup indices. Knowledge of distribution of the investors and their investment could be important. In general, the stage of development is substantial for developing the market. Higher stage of development means that this market is closer to an efficient market. Thus, the capability to accept a new stock is more. When there exist investors with limited investment (less risk-taking investors) higher activity and lower risk could be more important. The Food index with highest stage of development is closer to an efficient market but with its lower activity and higher risk for its development, we need more risk-taking investors (the more investment one has, the more risk he will take). In contrast, Bank with highest activity and lowest risk has the middle place in the stage of development. Thus, if investors with limited investment exist, these two parameters are more important. Hence, for development and privatization, knowing the distribution of the investors and their investment and also studying the human psychology is necessary.

V. CONCLUSION

In this chapter, we have studied some concepts, which are important to develop and privatize markets by Level Crossing approach. We have calculated some parameters of indices which are effective parameters in development and privatization of markets. These

TABLE I: The values of waiting time, $\tau(\alpha)$ for different levels, α for some TEPIX subgroup indices.

Index	$\tau(\alpha = 0)$	$\tau(\alpha = -0.005)$	$\tau(\alpha = 0.005)$	$\tau(\alpha = -0.01)$	$\tau(\alpha = 0.01)$	$\tau(\alpha = -0.02)$	$\tau(\alpha = 0.02)$
Bank	8.53	9.38	11.24	15.39	21.45	32.18	54.46
Medicine	7.87	22.47	31.47	78.68	64.35	353.98	236.02
Chemical products	7.61	11.42	14.45	29.50	59.00	88.50	101.14
Automobile	7.30	16.09	19.14	35.40	47.19	70.80	176.99
Investment	6.74	15.73	30.78	33.70	78.68	56.64	236.02
Food	5.95	20.23	44.27	37.26	101.11	64.36	236.02

TABLE II: The values of total number of crossings with positive slope for some TEPIX subgroup indices, $N_{tot}^+(q = 0)$ (activity), their shuffled, surrogate, their relative differences between original data & their shuffled (stage of development) and surrogate (deviation from a normal distribution) and comparison of them with Hurst exponents.

Index	N_{tot}^+	N_{sh}^+	N_{su}^+	$ N_{sh}^+ - N_{tot}^+ /N_{tot}^+$	$ N_{su}^+ - N_{tot}^+ /N_{tot}^+$	H
Automobile	157.60	217.85	374.19	0.38	1.37	0.71 ± 0.02
Medicine	162.57	222.49	339.56	0.37	1.09	0.64 ± 0.02
Bank	164.28	218.31	389.83	0.33	1.37	0.61 ± 0.02
Chemical products	163.89	212.61	385.44	0.30	1.35	0.60 ± 0.02
Investment	158.87	203.67	390.56	0.28	1.46	0.56 ± 0.02
Food	138.17	164.20	408.60	0.19	1.96	0.55 ± 0.02

parameters include: activity, stage of development, risk and investment horizons (which depends on waiting time). The subgroups with higher activity and stage of development and lower risk and appropriate investment horizons (the waiting time interval that one should wait for a specific change in the price value) are more suitable for development and privatization than other subgroups. This method is based on stochastic processes which should grasp the scale dependency of any time series in a most general way. We have applied this method to 6 selected subgroup indices (Bank, Medicine, Food, Automobile, Investment,

Chemical products) of Tehran stock market and compared their properties.

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